

PRODUCT PROFILE—

VI/SCANTM

IRIG FORMAT VIDEO SCANNER

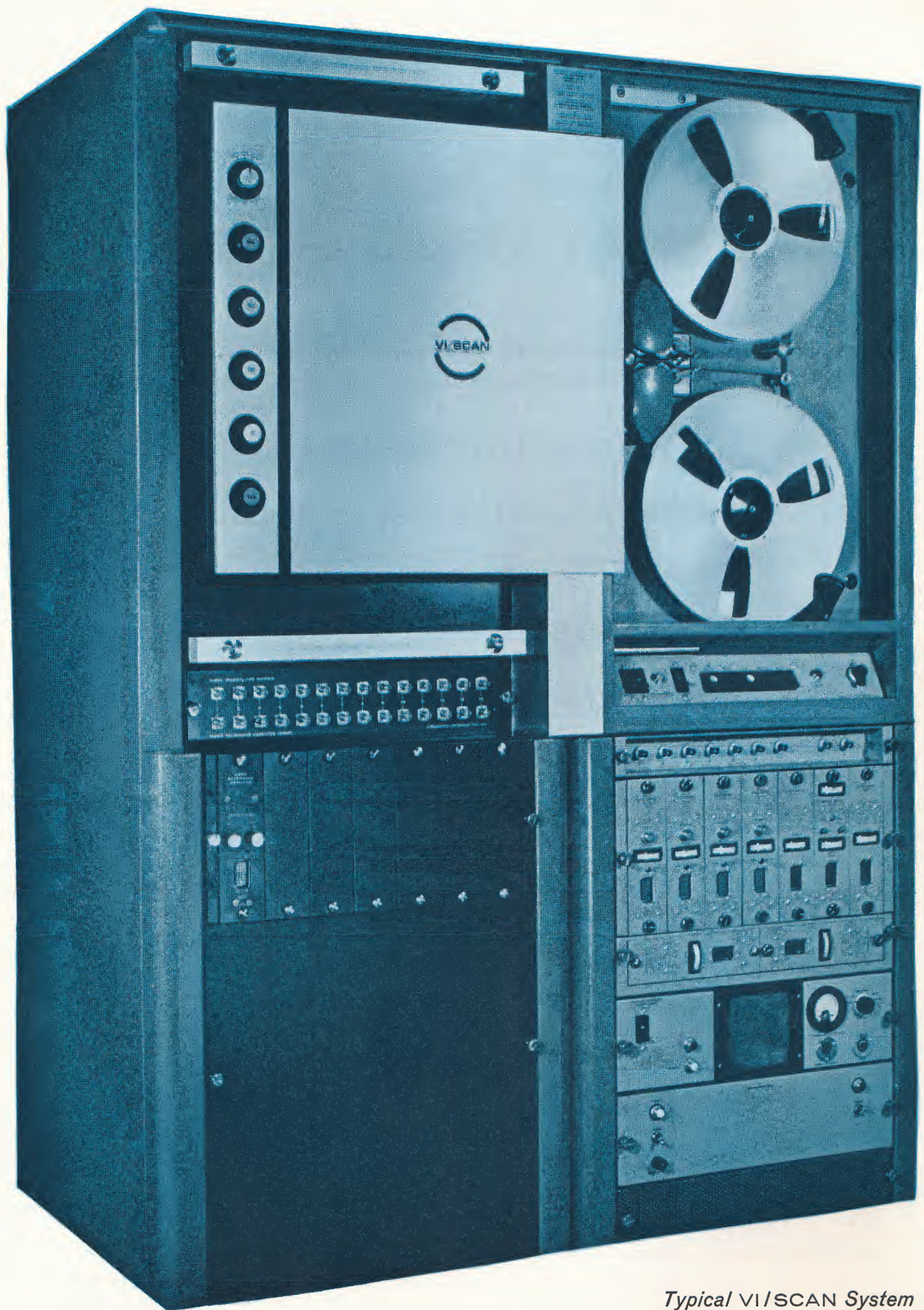
A New and Unique Concept in Magnetic Tape Recording and Real-Time Scientific Data Processing. Particularly Suited for—

- Auto and Cross Correlation Analysis
- Time Division Multiplexing Without Loss of Data due to Discrete Sampling
- Speech Expansion and Compression
- Wide-range, Linear Frequency Multiplication and Division
- Analog Tapped Delay Line Operations
- Magnetic Tape Loop Operation Without Tape Cutting and Splicing

VI/SCAN Systems are Capable of Recording and On-Line Scanning of 14-Channel IRIG Format Tapes with Reproduced Frequency Response from 100 cps to More Than Three Megacycles.

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Typical VI/SCAN System

TABLE OF CONTENTS

	PAGE
Introduction	4
VI/SCAN System Description	5
General VI/SCAN Application Information	6
Real-Time Processing Applications	6
Real-Time Auto and Cross Correlation Analysis	7
On-Line Time Division Multiplexing Without Loss of Data	7
Real-Time, Wide Range Frequency Multiplication and Division	7
Analog Tapped Delay Line	8
Magnetic Tape Loop Type Operation With No Cutting or Splicing	8
Off-Line Operations	8
Speech Expansion and Compression Analysis	8

INTRODUCTION

THE FOLLOWING INFORMATION will acquaint you with the VI/SCAN concept; both the hardware aspects—principally the use of a longitudinally scanning headwheel in the tape path—which results in its unique data processing capabilities, and some of its more important uses. Detailed equipment characteristics are contained in individual system specification sheets.

VI/SCAN's unusual data processing characteristics are dependent on achievement of extremely wide (video) playback bandwidths at very high head-to-tape speeds. Practical, reliable operation is made possible by the development of a film of lubricating air between the scanning heads, scanning headwheel and magnetic tape. The film, which must be extremely thin and stable, reduces head wear, tape wear and wheel driving requirements. This technique has made it possible to scan the same 16 inch length of tape more than 6 million times before a six decibel reduction in playback amplitude occurred. VI/SCAN's success represents a significant advancement in the state of the magnetic recording art.

There are many more applications for the VI/SCAN technique than has been possible to describe in this booklet. In addition to the applications covered, a VI/SCAN System may be used to process a tape pre-recorded in the field. Furthermore, despite the fact that VI/SCAN Systems are primarily designed for making and processing analog and FM recordings, the basic technique is readily adaptable to digital recording modes. Your inquiries concerning specialized applications or equipment variations are cordially invited.

VI/SCAN System Description

THE UNIQUE capabilities of the VI/SCAN System are a result of its ability to record and/or reproduce IRIG compatible tapes in the conventional fashion while simultaneously repetitively scanning these tapes with one of several interchangeable scanning headwheels. The scanning process can be carried out bi-directionally while the tape is either in motion or stopped. The combination of available headwheels and headwheel speeds results in a wide range of relative head-to-tape scanning velocities, scanning rates, scan lengths and reproduce bandwidths.

Figure 1 illustrates how scanning is accomplished. In it are seen, in simplified form, the modified tape path and the functional subsystems of VI/SCAN. Each of the interchangeable headwheels has IRIG format multi-channel heads spaced around its periphery. At least one of these heads is longitudinally scanning the tape at all times. Because the

headwheels have different diameters they scan different tape lengths at different circumferential velocities when rotated at the same angular rate. The multi-speed headwheel drive subsystem is used to achieve different scanning rates and reproduce bandwidths for each headwheel. Standard VI/SCAN designs provide scan lengths that range from 1 inch to 30 inches, scan rates that range from $3\frac{3}{4}$ to 120 scans per second and reproduce bandwidths that extend from 100 cps to 3.2 megacycles. Heads are spaced at 90 or 180 degree increments. The wide reproduce bandwidths result from the extremely high scanning velocities (approx. 2,000 ips for a 16 inch scan at 120 scans per second).

Figure 2 shows a VI/SCAN System with a 30 inch scan headwheel installed. Figures 3 and 4 are closeups of 2 inch scan and 16 inch scan headwheels. Standard VI/SCAN Systems are completely com-

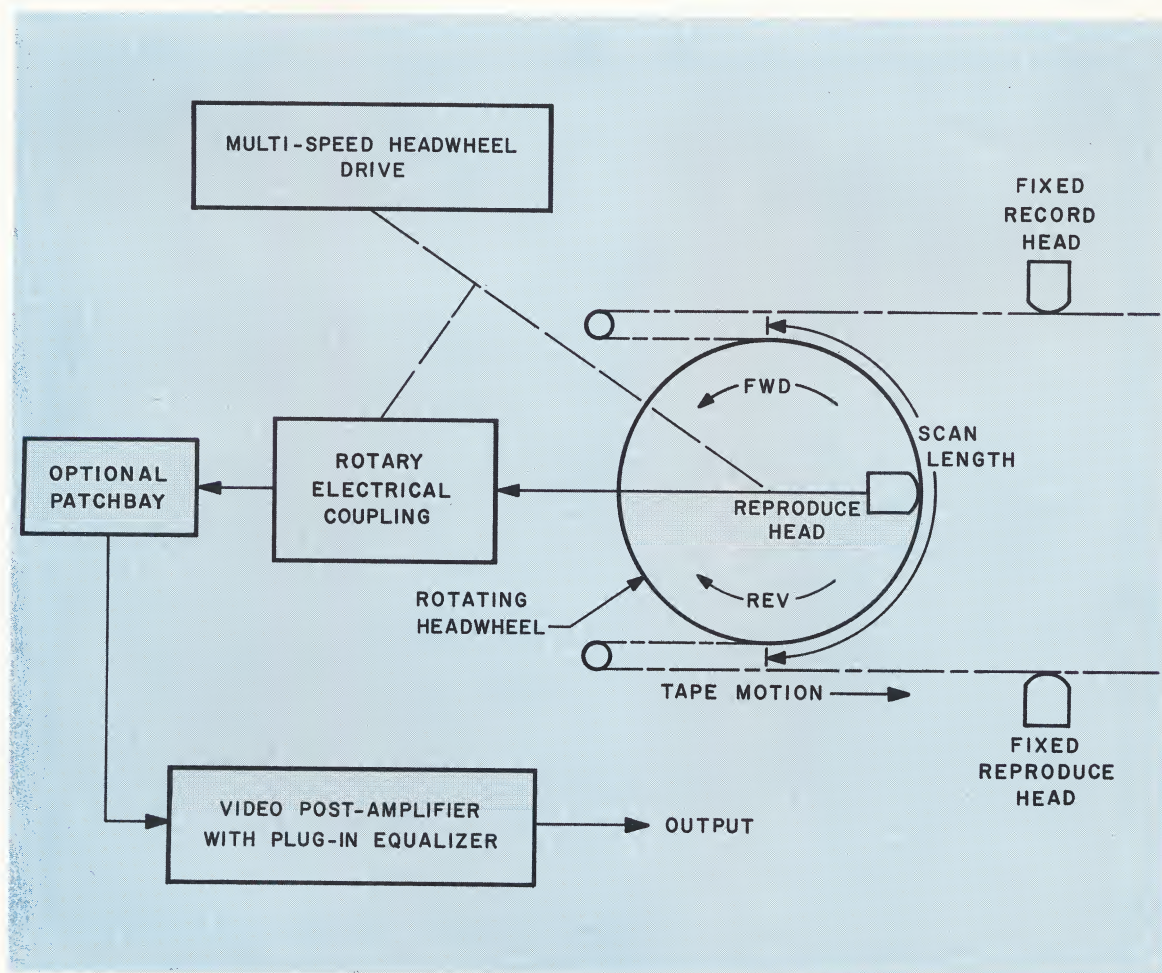


FIGURE 1—VI/SCAN SIMPLIFIED FUNCTIONAL DIAGRAM

patible with the IRIG analog tape format; they can be supplied with up to 14 channels on 1 inch wide tape or 7 channels for ½ inch wide tapes. The incorporated IRIG format recorder/reproducer may be operated independently if desired. When the

recorder/reproducer is operated in the VI/SCAN system, all normal control modes are available and inter-connected with the headwheel controls to provide proper start-up and shut-down sequences, correct tape tension and safety interlocks.

General VI/SCAN Application Information

THE VI/SCAN concept offers the researcher, engineer, and scientific investigator a new and unique approach to the solution of many problems in instrumentation and data reduction. The wide range of operating parameters and the IRIG compatibility of

VI/SCAN make it a general purpose device suitable for a variety of recording/data processing applications. In the following pages we define a few of its major application areas. However, VI/SCAN's usefulness is by no means limited to the systems described.

Real-Time Processing Applications

USING THE VI/SCAN rotating head to scan information as it is being recorded results in real-time data analysis or processing. The original data is permanently recorded and stored on reels; hence,

VI/SCAN also provides a large-scale permanent memory. The information in the memory may subsequently be processed as many times as desired using any one of the following techniques.

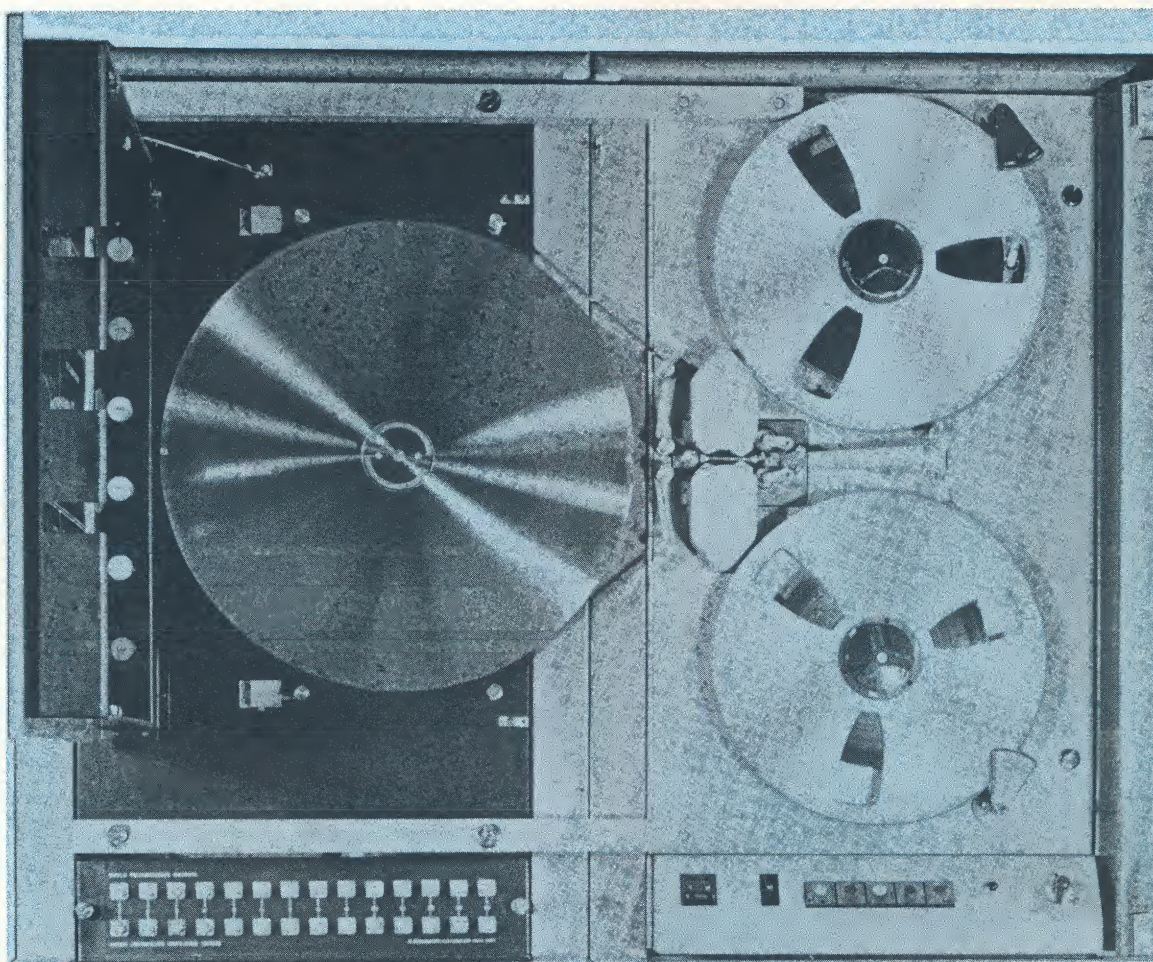


FIGURE 2—VI/SCAN SYSTEM WITH 30-INCH SCAN HEADWHEEL

REAL-TIME AUTO AND CROSS CORRELATION ANALYSIS:

VI/SCAN can, by repetitively scanning the tape as it is being moved past the rotating head, delay signals for the purpose of correlation analysis. Each segment of tape will be reproduced with incrementally increasing time delays. The scanned signal may then be compared with the real-time signal occurring on

the same information channel (auto or self-correlation) or with a signal on another information channel (cross correlation). The variety of available scanning speeds, scan lengths, tape speeds and 14 information channels result in a wide range of correlation analysis parameters.

ON-LINE TIME DIVISION MULTIPLEXING WITHOUT LOSS OF DATA:

VI/SCAN, by scanning the tape memory rapidly as it is passing the rotating head, will repetitively reproduce the information contained in each tape segment and simultaneously multiply the time base. This *output signal redundancy and time base multiplication* permits time division multiplexing of information on any combination of the available 14 channels, with-

out loss of data. By commutating between output channels for successive scans of the rotating head, a single, time-divided, multiplexed information channel is derived containing *all* of the information from each of the original channels. Conventional time sampled multiplex systems, on the other hand, lose data due to the discrete sampling methods employed.

REAL-TIME, WIDE-RANGE FREQUENCY MULTIPLICATION AND DIVISION

SELECTING THE VI/SCAN scanning head-to-tape speed so that it is different than the linear (record) speed, results in a time base shift; that is, the time base of the reproduced signal is multiplied by the ratio of the relative reproduce speed to the recorded speed without the introduction of non-linearities or other distortion. Among the many applications for frequency multiplication is the extraction of low frequency information, such as sonar echoes, from

background noise. Filtering such signals with conventional techniques is extremely difficult. By multiplying the time base, filters with sharp cut-off characteristics can be employed, thereby improving the signal-to-noise ratio by limiting noise to the information band-pass. Frequency division may be used to repeatedly display rapidly changing signals on X-Y plotters or pen recorders, whose normal writing speeds are too low for direct recording and display.

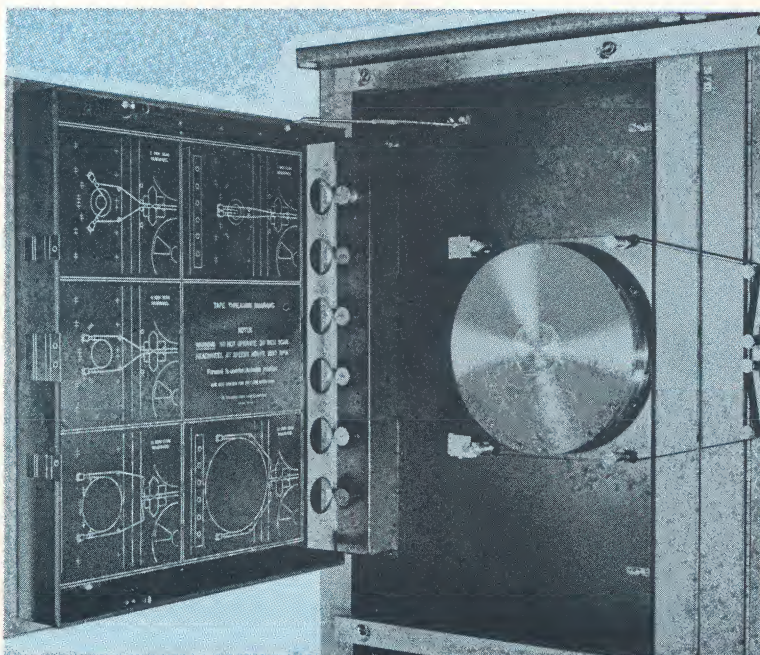


FIGURE 3—CLOSEUP OF 2-INCH SCAN HEADWHEEL

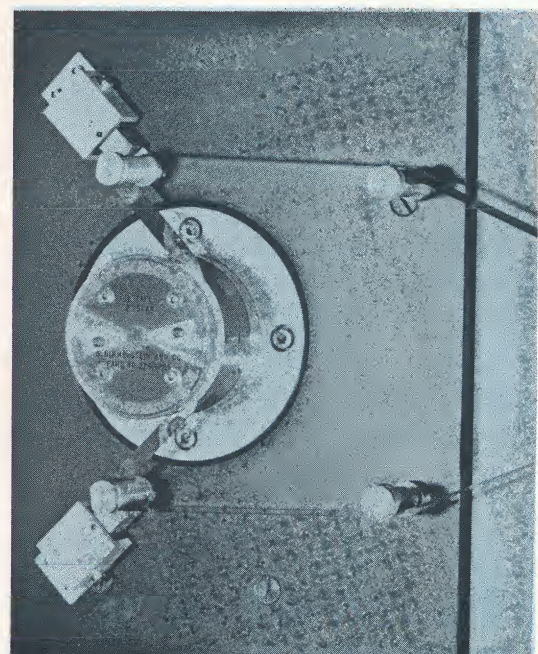


FIGURE 4—CLOSEUP OF 16-INCH SCAN HEADWHEEL

ANALOG TAPPED DELAY LINE:

WITH THE TAPE stopped, the information on a length of tape is scanned repetitively by the rotating head. VI/SCAN, therefore, may be used as a re-circulating delay line. By moving the tape past the rotating head, the delay (time when each tape segment is reproduced) changes incrementally, thus simulating the operation of a tapped delay line. Furthermore, the use of additional reproduce heads equally spaced around the headwheel periphery is completely anal-

ogous to additional taps which, if used, provide for simultaneous outputs with either constant or incrementally increasing delays. Operation may be carried on in real-time; this process is extremely useful for performing dynamic analysis with analog computing systems. The recorded information is not destroyed when reading or when moving to a new segment of tape. Therefore, VI/SCAN operates as an analog tapped delay line combined with a large memory.

MAGNETIC TAPE LOOP TYPE OPERATION WITH NO CUTTING OR SPLICING:

WHEN REDUCING or analyzing recorded data, it is often desirable to examine the information in an iterative fashion. The most commonly used technique is to locate the data of interest, then cut it out of the reel and splice it into a loop. Generally, a separate tape transport is used to repetitively reproduce the tape loop. VI/SCAN, by repetitively scanning the tape while it is stopped, performs an identical function to that described above. The tape may also be moved

as it is being scanned. As each tape segment may be played back many times before leaving the running area, real-time tape loop operation is achieved. The variety of scan lengths and rotational speeds (bi-directional) plus the availability of up to 14 information channels for transient and other data analysis can, for many applications, obsolete scissors, razor blades and splicing tape. Tape contamination by excessive handling will also be eliminated.

Off-Line Operations

ANY OF THE DATA processing techniques described above can be accomplished off-line, e.g., either on a pre-recorded tape or on the VI/SCAN produced tape, long after it was recorded. The following application is restricted to an off-line operation.

SPEECH EXPANSION AND COMPRESSION ANALYSIS:

SPEECH EXPANSION and compression have become an important area of investigation in both communication and psychological fields. Conservation of communication links, intelligibility studies, tailoring speeches to fit available time, language studies and most recently, attempts to communicate with por-

poises are a few of the major uses for speech expansion and compression equipment. Selecting the speed of the VI/SCAN rotating headwheel and the linear speed of the moving tape so that the relative head-to-tape speed is the same as that at which the tape was recorded, will result in a sampled playback without frequency spectrum (pitch) shift. The direction of rotation of the headwheel with respect to the tape motion determines whether speech expansion or compression results. Compression and expansion ratios up to 2:1 are highly intelligible. The many speed combinations available in standard VI/SCAN systems yield expansion and compression ratios well in excess of the normal intelligibility range.

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TECHNICAL SPECIFICATION—

VI/SCANTM I

IRIG FORMAT VIDEO SCANNER



VI/SCAN I
*is an IRIG
Compatible
System
Designed
to Yield
Maximum
Versatility
Using the
VI/SCAN
Data
Processing
Technique.*

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PATENT APPLIED FOR

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VI/SCAN_{TM} I System

GENERAL DESCRIPTION

VI/SCAN I is a complete record/reproduce system incorporating the unique data processing features of the VI/SCAN technique. It is capable of recording and reproducing up to 7 channels of analog information on ½ inch wide tape or 14 channels of analog information on 1 inch wide tape—both compatible with IRIG analog tape standards per Document No. 106-60. Recorded tapes may be processed on a real-time basis using any one of 6 interchangeable scanning wheels. A pre-recorded IRIG format tape may also be processed.

Scan lengths vary from 1 inch up to 30 inches with standard headwheels; interchangeable guides are used to convert from ½ inch wide to 1 inch wide tapes. Three electrically changeable motor speeds and 3 manually changeable belt ratios provide 9 scanning rates per headwheel. Combinations of these parameters result in scanning velocities from 3¾ ips to 1,920 ips and reproduce bandwidths to 3.2 megacycles, maximum. Plug-in networks are used to

equalize headwheel response over the useful operating bandwidth.

Head and tape wear are virtually eliminated by providing a thin, stable air film for high speed operation. An electrically interlocked combination safety/dust cover encloses the headwheel assembly and shields operating personnel. Equipment construction conforms to the highest instrumentation standards. All critical points in the drive system use high precision permanently lubricated bearings, stainless steel shafts, tape guides, etc.

VI/SCAN I incorporates either a CEC Type GR-2500 or GR-2800 IRIG Record/Reproduce System. The IRIG transport may be utilized independently of the scanning subsystem. When used for VI/SCAN processing, all control circuits are interlocked for proper start-up/shut-down sequences, correct tape tension, and safety factors. All normal transport control modes are operable after the start-up cycle is completed.

SYSTEM CHARACTERISTICS

TEMPERATURE: Operating temperature range is 50° to 110°F.

SIZE & WEIGHT: With a GR-2500 IRIG Transport—67" high x 48" wide x 28" deep—weighing 1,500 pounds for a 7-channel system; 67" high x 72" wide x 28" deep—weighing 2,200 pounds for a 14-channel system.

With a GR-2800 IRIG Transport—73¼" high x 46¼" wide x 25" deep—weighing 1,300 pounds for a 7-channel system, or 1,450 pounds for 14 channels.

POWER: Nominal 115 volts, 60 cps, single phase. Maximum requirement for 14-channel system is 3.2 kva. Circuit breakers are provided to safeguard all A.C. input lines.

SCANNING SUBSYSTEM CHARACTERISTICS

Six interchangeable headwheels, each with interchangeable guides for ½ inch or 1 inch wide tape, are available. The following tabulation summarizes the scanning parameters they provide. The tape scan angle (mechanical angle defined by tangent points between wheel and tape) is adjustable over ±10°.

All magnetic heads conform to IRIG Standards, i.e., azimuth angle is 90°00' ±1', gap scatter is ±50 microinches, track location is 0.070" ±0.002" center-to-center, effective track width is 0.050" ±0.002", separation of interlaced stacks is 1.500 ±0.001". Head construction is all metal.

WOW & FLUTTER: Angular flutter of the headwheel, with tape either in motion or stopped, is 0.3% peak-to-peak maximum measured over a bandwidth from 0.5 to 300 cps.

CONTROLS: Fully interlocked manual controls are provided for the following functions: SCANNING SPEED, FORWARD, REVERSE, STOP, POWER ON, POWER OFF.

TABLE I
STANDARD HEADWHEEL PARAMETERS

Headwheel Type	224-1325	224-1324	224-1400	224-1323	223-1322	224-1321
Scan Length	1" $\pm$.001"	2" $\pm$.002"	4" $\pm$.007"	8" $\pm$.002"	16" $\pm$.004"	30" $\pm$.008"
Scan Angle (Nominal)	180°	90°	90°	180°	180°	180°
Distance From Record Head to Start of Scan:						
From Stack No. 1 (Odd)	20¾"	18⅝"	22½"	20¼"	27¼"	29⅜"
From Stack No. 2 (Even)	19¼"	17⅞"	21"	18¾"	25¾"	27⅞"
*Scan Velocity Scan Rate	3.75 ips @ 3.75 SPS**	15 ips @ 7.5 SPS	30 ips @ 7.5 SPS	30 ips @ 3.75 SPS	60 ips @ 3.75 SPS	112.5 ips @ 3.75 SPS
Scan Velocity Scan Rate	7.5 ips @ 7.5 SPS	30 ips @ 15 SPS	60 ips @ 15 SPS	60 ips @ 7.5 SPS	120 ips @ 7.5 SPS	225 ips @ 7.5 SPS
Scan Velocity Scan Rate	13 ips @ 13 SPS	52 ips @ 26 SPS	104 ips @ 26 SPS	104 ips @ 13 SPS	208 ips @ 13 SPS	390 ips @ 13 SPS
Scan Velocity Scan Rate	15 ips @ 15 SPS	60 ips @ 30 SPS	120 ips @ 30 SPS	120 ips @ 15 SPS	240 ips @ 15 SPS	450 ips @ 15 SPS
Scan Velocity Scan Rate	26 ips @ 26 SPS	104 ips @ 52 SPS	208 ips @ 52 SPS	208 ips @ 26 SPS	416 ips @ 26 SPS	780 ips @ 26 SPS
Scan Velocity Scan Rate	30 ips @ 30 SPS	120 ips @ 60 SPS	240 ips @ 60 SPS	240 ips @ 30 SPS	480 ips @ 30 SPS	900 ips @ 30 SPS
Scan Velocity Scan Rate	52 ips @ 52 SPS	208 ips @ 104 SPS	416 ips @ 104 SPS	416 ips @ 52 SPS	832 ips @ 52 SPS	1560 ips @ 52 SPS
Scan Velocity Scan Rate	60 ips @ 60 SPS	240 ips @ 120 SPS	480 ips @ 120 SPS	480 ips @ 60 SPS	960 ips @ 60 SPS	—
Scan Velocity Scan Rate	120 ips @ 120 SPS	480 ips @ 240 SPS	960 ips @ 240 SPS	960 ips @ 120 SPS	1920 ips @ 120 SPS	—

*For line frequency of 60 cps, tolerance of scanning velocity and rate is $\pm 0.1\%$. Scan Velocity is circumferential velocity of scanning head; actual head-to-tape speed is Scan Velocity plus or minus (headwheel is bi-directional) linear tape speed. Scan Rate is the quotient of Scan Velocity and Scan Length. If the tape is in motion while it is being scanned, the effective scan rate may be computed as follows:

$$\text{Effective Scan Rate} = \frac{\text{Scan Velocity}}{\text{Scan Length}} \mp \frac{\text{Linear Tape Speed}}{\text{Scan Length}}$$

With the tape in motion, the number of times each segment of tape is scanned may be computed as follows:

$$\text{Number of Scans} = \frac{\text{Scan Velocity}}{\text{Tape Speed}} \pm 1$$

Where + sign is used when Scan Vector is in direction opposite to tape motion.

EXAMPLE: Tape Speed = 60 ips, Scan Velocity = 1920 ips in direction of tape travel, Scan Length = 16"

**SPS = Scans per second. Effective Scan Rate = 116.25 SPS
Number of Scans = 31

SCANNING REPRODUCE ELECTRONICS

Modular construction is used throughout. With the exception of Nuvistor coupling and output stages in the Video Post-Amplifier package, all electronic circuitry (video preamplifiers, regulated power supplies, etc.) is solid state. Standard input and output (signal) connectors are BNC. Plug-in equalizers are

used to provide flat response (within ± 3 db) for the scan rates and scan lengths tabulated below. Other system specifications apply to standard equalized headwheels per this tabulation. Additional equalized frequency ranges can be provided to cover the entire scanning capability of the system; see Table I.

TABLE II
STANDARD VI/SCAN I ANALOG EQUALIZED BANDWIDTHS
VERSUS SCANNING PARAMETERS

Scan Rate (Scans/Sec.)	SCAN LENGTHS					
	1"	2"	4"	8"	16"	30"
7.5	.15-12.5 KC	.30- 25 KC	—	1.2-100 KC	—	—
15	.30- 25 KC	.60- 50 KC	2-120 KC	4-240 KC, or 2.4-200 KC	—	—
30	.60- 50 KC	1.2-100 KC	4-240 KC	8-480 KC, or 4.8-400 KC	—	—
52	—	—	—	—	—	300-3130 KC
60	1.2- 100 KC	2.4-200 KC	—	9.6-800 KC	19.2-1600 KC	—
120	—	4.8-400 KC	—	—	38.4-3200 KC	—

HARMONIC DISTORTION: When a 10 kc signal is recorded at 60 ips and scanned at any standard scanning rate and with any standard headwheel, the third harmonic distortion will be less than 1% @ rated output level.

OUTPUT LEVEL: 1 volt RMS into 1,000 ohms.

IRIG TRANSPORT SUBSYSTEM

The following abbreviated specifications apply when either of the two optional transport subsystems are supplied as part of VI/SCAN.

TAPE SPEEDS: 60, 30, 15, 7.5, 3.75, 1.875 ips; all $\pm 0.2\%$ at 60 cps line frequency.

TAPE CAPACITY: Accommodates NAB hub equipped reels up to 14" in diameter; either $\frac{1}{2}$ inch or 1 inch wide tapes with either 1 mil or $1\frac{1}{2}$ mil polyester base.

WOW & FLUTTER: Less than 0.25% peak-to-

OUTPUT IMPEDANCE: Less than 100 ohms.

SIGNAL-TO-NOISE RATIO: RMS Signal-to-RMS Noise ratio is at least 30 db when measured over the scanning bandwidth, worst case—with the amplitude of any signal frequency within the passband used as a reference.

peak over a 0.2 cps to 10 KC bandwidth at 60 ips.

START TIME: 3 seconds.

STOP TIME: 2 seconds.

TAPE MOTION CONTROLS: Fast Forward, Rewind, Stop, Reproduce, Record.

FREQUENCY RESPONSE: 100 cps to 100 KC at 60 ips; flat within ± 3 db. Proportionately lower at other tape speeds.

SIGNAL-TO-NOISE RATIO: 35 db RMS signal-to-RMS Noise.

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